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Passive PE Sampling in Support of In Situ Remediation of Contaminated Sediments: Standard Operating Procedure for PED Deployment

ESTCP Project ER-200915

December 2012

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REPORT DOCUMENTATION PAGE				<i>Form Approved OMB No. 0704-0188</i>		
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1. REPORT DATE (DD-MM-YYYY) 12-2012		2. REPORT TYPE Guidance Document		3. DATES COVERED (From - To) 12-2008-12-2012		
4. TITLE AND SUBTITLE Passive PE Sampling in Support of In Situ Remediation of Contaminated Sediments (Standard Operating Procedure for the Deployment and Retrieval of Polyethylene Devices in Sediment)				5a. CONTRACT NUMBER		
				5b. GRANT NUMBER		
				5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S) Philip Gschwend John MacFarlane Kevin Palaia Steve Reichenbacher Dean Gouveia				5d. PROJECT NUMBER ER-200915		
				5e. TASK NUMBER		
				5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Massachusetts Institute of Technology 15 Vassar St., Bld 48, Rm 413 Cambridge, MA 02139				8. PERFORMING ORGANIZATION REPORT NUMBER ER-200915		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) SERDP/ESTCP 4800 Mark Center Drive, Suite 17D08 Alexandria, VA 22350-3605				10. SPONSOR/MONITOR'S ACRONYM(S) SERDP/ESTCP		
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)		
12. DISTRIBUTION/AVAILABILITY STATEMENT Unlimited						
13. SUPPLEMENTARY NOTES						
14. ABSTRACT <p>The purpose of this Standard Operating Procedure (SOP) is to provide a description of the methods used in the deployment and retrieval of polyethylene devices (PEDs) in sediment-pore water environments for the sampling of hydrophobic organic compounds (HOCs) such as polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). The overall objective of PED sampling is to determine the horizontal and vertical distributions of HOCs in pore waters of bed sediments. This SOP does not discuss deployment of PEDs in atmospheric or aqueous systems. This SOP should be used in conjunction with companion SOPs for Preparation of Polyethylene (PE) Media and Extraction Procedures for PE Media.</p>						
15. SUBJECT TERMS						
16. SECURITY CLASSIFICATION OF: a. REPORT b. ABSTRACT c. THIS PAGE			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES 11	19a. NAME OF RESPONSIBLE PERSON Carmen Lebron 19b. TELEPHONE NUMBER (Include area code) 617-253-1638	

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Standard Operating Procedure

Deployment and Retrieval of Polyethylene Devices (PEDs) in Sediment

1.0 Scope and Objective

The purpose of this Standard Operating Procedure (SOP) is to provide a description of the methods used in the deployment and retrieval of polyethylene devices (PEDs) in sediment-pore water environments for the sampling of hydrophobic organic compounds (HOCs) such as polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). The overall objective of PED sampling is to determine the horizontal and vertical distributions of HOCs in pore waters of bed sediments. This SOP does not discuss deployment of PEDs in atmospheric or aqueous systems. This SOP should be used in conjunction with companion SOPs for *Preparation of Polyethylene (PE) Media* and *Extraction Procedures for PE Media*.

The installation and retrieval methodologies discussed in this SOP are general in nature and may be modified to meet the handling or analytical requirements of the contaminants of concern, as well as constraints presented by site conditions or equipment limitations. If modifications are made, they should be appropriately documented in site planning documents (e.g., Work Plan, Sampling and Analysis Plan, Quality Assurance Project Plan [QAPP]), a field logbook, and in reports summarizing field activities and analytical results.

The methodologies in this SOP are applicable to PED sampling of sediments situated under static aqueous layers (i.e., lakes, ponds, wetlands, or impoundments) and flowing waters (i.e., rivers, streams) which may be of a marine, brackish, or a fresh water nature, at water depths generally less than 100 feet. The degree of difficulty of PED deployment and retrieval increases as water depths, currents, and wind speeds increase. For the purpose of this procedure, sediments are those mineral and organic materials situated beneath an aqueous layer. PEDs assembled, installed, and retrieved following these procedures will be suitable for laboratory measurements.

2.0 Summary of Methods

Field personnel should wear nitrile gloves while performing the procedures described in this SOP so as to avoid transferring contaminating HOCs to the PEDs. Potential hazards associated with the planned tasks should be evaluated prior to conducting field activities. A site-specific Health and Safety Plan (HASP) should provide a description of potential hazards and associated safety and control measures.

PEDs are typically constructed from (a) polyethylene sheet prepared as described in the companion SOP, *Preparation of Polyethylene (PE) Media*, and (b) aluminum sheet metal (Figure 1). PEDs are assembled by mounting the laboratory-provided PE strip within a

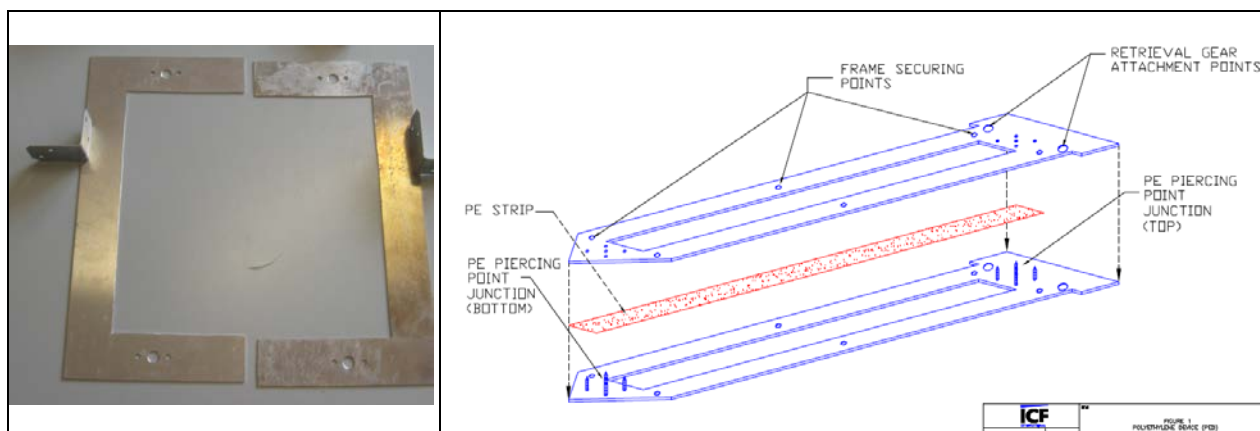


Figure 1.
 (left panel) Aluminum sheet cut into two "C-shaped" pieces allowing one to mount and hold ~25 cm strips of PE an open window when the two pieces are overlapped and bolted together.
 (right panel) Drawing of two aluminum sheet pieces cut so as to sandwich a strip of PE and expose about 50 cm of length.

decontaminated aluminum PED frame. Generally, the machine screws used to hold the two pieces of aluminum sheet together are also used to pierce the PE sheet and hold it stretched across the open window. Pointed aluminum sheet can be used to assist in subsequent field insertions into cohesive sediment beds. It is also useful to use a dremel tool to inscribe the aluminum frame with an identifying label.

After the PE is placed in the Al frame, the entire assembly is carefully wrapped completely in solvent-cleaned (e.g., dichloromethane), heavy-duty, aluminum foil. The wrapped samplers are also labeled on the outside for field crew identification, and then they are carefully arrayed in a clean shipping container (e.g., a cooler).

For deployment, additional equipment and lines can be used. For example, for PED insertion into relatively shallow sediments (<15 feet) from a boat, the PED frame can be inserted and locked into a Toggle-Locking Device (TLD), a device specifically designed for PED installations (Figure 2 left panel). This fitting can be connected to an adjustable extension painter's pole. The PED is then lowered into the water and down to the top of the sediment bed. The PED is pushed into the sediment so that the PE strip within the PED is positioned across the sediment-surface water interface. The PED is then unlocked from the TLD and left in place. For deployments in moderate depth waters (<60 feet), divers can be used to insert the PEDs in the bed sediment. Finally, at still deeper locations, PEDs can be affixed to a platform and lowered from a vessel to the bottom where the weighted vehicle causes the PEDs to be inserted in the bed (Figure 2, right panel). In all cases, recovery lines are attached to the PEDs via carabiners, and these lines may be tied to nearby pilings or marker buoys to locate the samplers for future recovery.

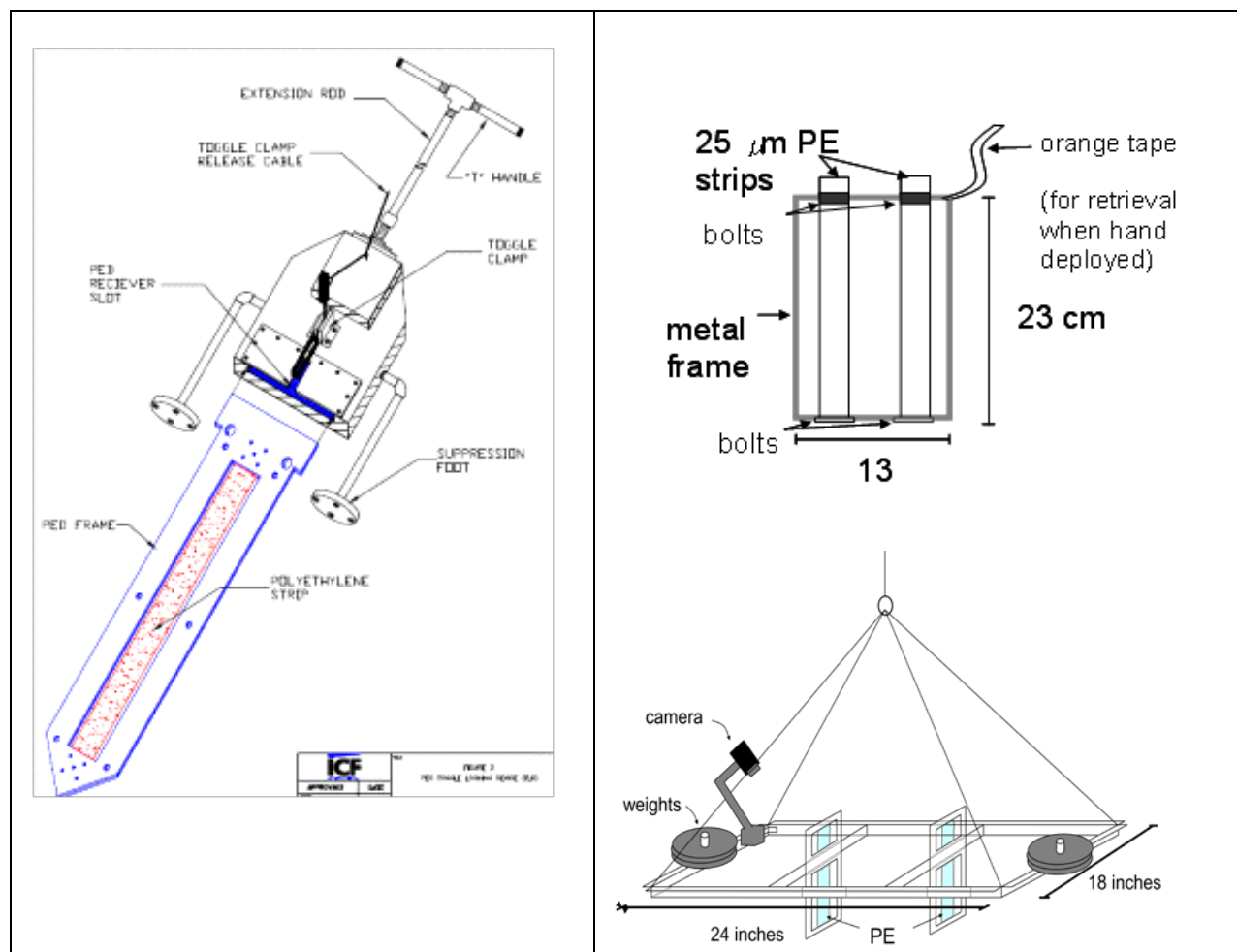


Figure 2. Illustrations of polyethylene strips mounted in aluminum sheet metal frames for field deployments into sediment beds. The left panel shows a larger sampler (~50 cm vertical opening) which can be inserted into the sediment beds using a releasable extension rod that can reach about 5 m deep while standing on a boat. The suppression feet insure positioning of the sampler at a known depth across the sediment-water interface. A line is attached to the toggle clamp to release the sampler from the deployment hardware after insertion into the sediment bed. The right panel shows a shorter sampler (vertical opening ~20 cm) suited to hand deployment in shallow/tidal locations or for mounting on a weighted frame that can be lowered from a vessel in deeper water. Both the short and long samplers can be deployed in intermediate water depths by divers.

PEDs are typically left in place for a period of weeks to months, depending on the HOCs of interest. These deployment times are usually too short to achieve sediment-PE equilibration of the HOCs, so it is necessary to measure the losses of the performance reference compounds (PRCs) in order to be able to correct target HOC concentrations to their equilibrated levels (Fernandez et al., 2009). During the deployment, the target HOCs diffuse into the PE from the surrounding sediments, while the performance reference compounds (PRCs) are simultaneously diffusing outwards.

Once retrieved, the PEDs are transported to a clean laboratory. Here, the surfaces of the PE strip are wiped clean, the PE is cut into appropriate section lengths, and the cut pieces are transferred to clean glass vials for shipping to a laboratory for analysis.

3.0 PED Sample Preservation, Handling, and Storage

The following procedures should be followed during preservation, handling, and storage of PE and PEDs.

- If PE strips are provided by the contracted laboratory, the PE will have been cleaned and equilibrated with performance reference compounds (PRCs); the PE strips will be shipped in sealed glass containers; and they will be ready for installation into the PED frame. In some instances.
- In some cases, the assembled PEDs may be shipped from the laboratory with the PE strip already installed.
- The PE strips are susceptible to contamination from atmospheric vapors and contact with surfaces (i.e., worker hands). Nitrile gloves should be worn at all times when handling the PE strips and PED frames.
- PED aluminum frames and hardware should be decontaminated prior to PE strip installation following standard EPA decontamination procedures (i.e., EPA SOP #2006) or site-specific Work Plan or QAPP procedures.
- Transfer of the PE strip to and from the PED frame should be done with solvent-rinsed stainless steel forceps. Organic solvent-rinsed aluminum foil (solvent chosen to clean foil of any HOCs in target set) should be used to cover any surface that clean PE or PEDs may encounter.
- Loaded PEDs should also be wrapped in solvent-rinsed aluminum foil both prior to and after recovery to prevent sampler exposures that might contribute background HOCs.
- Before shipping retrieved PE strips, it is recommended that each PE strip be wiped clean on both sides, cut into appropriate sections, and individual sections sealed in a pre-cleaned glass vial that contains a milliliter of distilled water. Solvent should not be added to the PE sections prior to shipment as leakage of solvent during shipping is a health hazard, risks undefined losses of HOCs from the sample, and can obliterate sample labels. Freeze shipping should also be avoided (do not want to change PE crystallinity); but cold packing may be necessary depending on the time of season and individual laboratory handling/quality control (QC) procedures.

4.0 Equipment

Equipment needed for PED preparation, assembly, deployment in relatively shallow waters (<15 feet), and retrieval may include:

- Boat
- Chain-of-custody forms
- Communication equipment (cell phone or radio)
- Coolers
- Extension rods, painter's pole.
- Global Positioning System (GPS) device
- Hand tools
- Logbook
- Maps/Sampling and Analysis Plan/field sampling forms
- Personal protective equipment (PPE) and safety equipment
- Nitrile gloves
- PE sample containers
- Pre-assembled PEDs
- Preprinted sample labels
- Sink rope
- Solvent-rinsed aluminum foil
- Sounding rod, fathometer, or weighted tape measure
- Spring links or carabiners
- Surface marker buoys
- "T" Handle
- Toggle Locking Device (TLD)

5.0 Procedures

The following sections describe the general methods and procedures for preparing, assembling, deploying, and retrieving PEDs from a sediment bed. These procedures can be used in both a flowing or non-flowing water body; however equipment requirements will depend on water depth and velocity.

5.1 Preparation

- Determine a sampling strategy, including identifying the objective(s), extent of the sampling effort, and specific sampling locations, in accordance with site-specific planning documents.
- Perform a general site survey to determine the conditions of the sampling area including water depths, water currents, and sediment bed material type (i.e., impediments such as cobble and exposed bedrock that may affect ease of being able to insert PEDs).
- Coordinate staff, client, abutters and regulatory agency involvement, as necessary.
- If not already performed by laboratory supplying PE, decontaminate PED frames and hardware following standard decontamination procedures. Assemble PED frames with laboratory-provided PE strips prior to deployment.
- Obtain necessary sampling and safety equipment.

- Obtain site access agreements and/or permits, as necessary.
- As necessary, pre-mark sampling locations with marker buoys using pre-determined geographic coordinates entered into a GPS device.

5.2 PED Assembly

PEDs can be pre-assembled with prepared PE strips a few days prior to deployment. It is recommended that assembled PEDs not be stored for more than 2 days. At least one PED should be used as a trip blank to ascertain substantial sampler changes during the deployment effort (e.g., accumulation of unexpected background contamination, significant depletion of PRCs). The following procedures should be followed when assembling the PEDs with a laboratory-provided PE strip:

- Don appropriate PPE, as required by the site-specific HASP.
- On a steady surface, lay the PED frame containing the PE piercing points (see Figure 1), sharp side up, on a sheet of clean aluminum foil.
- Wearing nitrile gloves and using a solvent-rinsed stainless steel forceps, remove the laboratory-provided PE strip from its container and lay the PE strip lengthwise across both sets of PE piercing point junctions. PE strips should be delivered from the laboratory at a pre-determined specified length, depending on the length of your PED and project objectives.
- At one end of the PED frame, gently push the PE strip onto the PE piercing points so all points penetrate the PE strip.
- Gently pull the other end of the PE strip over the adjacent PE piercing points, keeping the PE strip taut, and push that end of the PE strip into the PE piercing points. The tautness of the PE strip should have as minimal deflection as possible between the two PE piercing point junctions, but not too tight so that movement of the PE causes it to rip or tear.
- Place the other part of the PED frame over the portion of the PED frame containing the PE strip so that each of the PE piercing point junctions meet and both PED frames are flush against each other.
- Secure the two frames together using the appropriate hardware (stainless steel machine screws, locking washers, and cap nuts).
- Wrap the entire PED frame in clean aluminum foil to prevent exposure during transport and field preparation activities.

5.3 PED Deployment

PEDs can be installed from a boat platform or by wading into shallow water bodies or streams. In a stream or flowing water setting, always stand downstream of the sampling location; it is also recommended that samplers be aligned to present a minimal cross section to the flow direction so as to minimize bed scouring. Sample locations can be pre-marked or located using a

handheld GPS device. Prior to deployment, consider the possible retrieval methods, which may include stringing several PEDs together using sink rope or individually using single surface marker buoys, as described further in Section 5.4 (PED Retrieval). The following procedures detail PED deployment using a TLD:

- Don appropriate PPE, as required by the site-specific HASP.
- Locate the sediment sample location and record the water column depth using a sounding rod, fathometer, or weighted tape measure.
- Based on the water depth, attach the appropriate length of extension rods to the TLD along with the “T” handle (see Figure 2).
- Make sure the retrieval gear attached to the PED frame is functioning properly.
- Remove the loaded PED frame from its aluminum foil wrap and attached the retrieval gear (i.e., spring link or carabiner clips) to the retrieval gear attachment points along the top end of the PED frame (see Figure 1). Insert the top end of the PED frame, together with the attached retrieval gear, into the receiver slot of the TLD and secure the PED with the toggle clamp (Figure 2). Make sure the PED frame and toggle clamp are fixed firmly.
- The TLD should include a set of suppression feet which are used to prevent over-penetration of the PED into the sediment bed (Figure 2). If needed, the lengths of the suppression feet should be adjustable to provide accurate control of the penetration depth of the PED and to accommodate for various site conditions and project objectives. Extension rods can also be graduated in feet or inches to assist the sampler in knowing how far the PED has penetrated into the sediment bed. Avoid penetrating the PED too deep into the sediment bed. Pushing the entire PE strip below the sediment-surface water interface may cause later retrieval to be difficult, will complicate the determination of the exact location of the sediment-surface water interface, and will prevent data acquisition needed to characterize bed-to-water column concentration gradients.
- Carefully lower the TLD and PED into the water column, over the sampling location, to the top of the sediment bed. Using the “T” handle, push the PED vertically straight down into the sediment bed until you feel the resistance of the suppression feet against the sediment surface or until the desired depth is achieved. Keep the extension rods as vertical as possible when forcing the PED into the sediment to ensure the PED is installed straight (e.g., at a right angle to the sediment bed surface).
- Use the “T” handle, push directly down on the PED. Avoid rocking the “T” handle back and forth as this could damage the PE strip. If necessary, a hammer can be used on the “T” handle to help drive the PED into dense sediment substrates.
- Once the PED is installed at the appropriate depth within the sediment, release the toggle clamp on the TLD by pulling on the toggle clamp cable (Figure 2). This will release the PED frame from the TLD.
- If possible, try to work when the winds and water currents are calm, particularly if the water body is deep. Anchoring may be necessary to stabilize the boat and to ensure the PED is deployed at the planned sampling location.

- If for some reason the PED slips out of the TLD and needs to be re-installed, simply retrieve it using the retrieval gear and re-install following the procedures above. Make sure the PE strip is intact and note the sampler's re-use in the field logbook.
- Complete any required field sampling forms/documentation and move to next location.

5.4 PED Retrieval

The most important element to remember when retrieving the PEDs is maintaining the integrity of the PE strip once it is retrieved. PED retrieval methods vary and should be developed based on site-specific conditions. Regardless of the method, once the PED is retrieved and brought to the surface, the entire PED should be immediately wrapped in clean aluminum foil to protect the PE strip. After all the PEDs are collected, they can be transported to a more controlled environment (e.g., onshore) for processing. There, the PE strip is cleaned of coatings; it is photographed; the strip is cut into sections according to the sampling design (e.g., 5 cm lengths); each section is placed in a glass container that is labeled; and the samples are shipped to the analytical laboratory. If processing on the same day a PED is retrieved is not possible (although that is preferable), the entire PED frame may be labeled, wrapped in clean aluminum foil, and shipped to the laboratory where the laboratory would remove the PE strip from the PED.

This SOP discusses three common methods for retrieval of PEDs. Regardless of the retrieval method used, it is always a good idea to let the appropriate regulatory agencies and/or local authorities know that marker buoys may be installed in the water body.

5.4.1 Single Floating Marker Buoy

Individual PEDs can be attached to a single marker buoy by rope line or cable. It is suggested that a weighted sink line be used at all times for the rope line instead of nylon rope, which will tend to float on the water surface. Make sure there is sufficient slack in the line to account for wave action and water level fluctuation (e.g., tidal rise), and make sure the marker buoy line is securely fastened to the PED at the retrieval gear attachment points (see Figure 1). In some instances, it may be necessary to label the marker buoy with information relaying what the buoy is for, instructions to not disturb the buoy, and/or possible contact information.

Retrieval involves simply pulling vertically on the rope line or cable from a boat platform to dislodge the PED from the sediment and pulling the PED to the surface. In some instances a winch may be used.

5.4.2 Single Sub-Surface Marker Buoy

Sub-surface marker buoys are installed following the same techniques as floating marker buoys (Section 5.4.1) except the marker buoy is submerged a few feet below the water surface. The main purpose of this technique is to prevent curious onlookers from disturbing the PEDs. In order to set the marker buoys below the water surface, the water depth at the time of deployment should be determined as well as the possible magnitude of water level fluctuation

over the deployment period. Using this information, attach the marker buoy to the rope line so the buoy will be submerged a few feet below the water surface when the PED is installed. Make sure there is a sufficient length of slack line attached to the buoy because this will be used to retrieve the PED. In order to retrieve the PED, locate the submerged marker buoy, lower a gaff or large treble hook to retrieve the slack line, and pull the PED from the sediment in the same manner as described for floating marker buoys (Section 5.4.1).

5.4.3 Multiple PED Lines

This technique mimics how lobstermen set their traps and allows for numerous PEDs to be installed with a single marker buoy or in some cases no marker buoy at all. Using weighted sink rope, attach one end to an anchored floating buoy or tie it off to a secure object along the shoreline. Then proceed to the PED sample location on the water, letting out sink rope as you travel. Once the sample location is reached, tie a simple lineman's loop in the sink rope and attach it to the PED retrieval gear. The retrieval gear is then attached to the PED frame through the retrieval gear attachment points (see Figure 1). Install the PED following the PED deployment procedures described in Section 5.3. Once the PED is installed, continue on to the next sample location, letting out more sink rope as you travel. Once the second sample location is reached, repeat the above procedure and move on to the next sample location. This process allows for numerous PEDs to be installed across a lengthy distance, in a linear or non-linear mode, and without raising the curiosity of onlookers by using numerous floating marker buoys. If needed, marker buoys can be installed midway and/or at the end of the line.

In order to retrieve the PEDs, simply grab hold of the end of the sink rope and coil it up as you move to the first sample location. Once the sample location is reached, pull on the sink rope and retrieve the PED. Detach the retrieval gear from the linesman loop and wrap the entire PED in clean aluminum foil, and move on to the next location and repeat. In the event one of the PEDs cannot be retrieved, the sink rope which continues to the next PED must be retrieved.

6.0 Quality Assurance/Quality Control

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following QA procedures are suggested:

- All data must be documented in field sampling forms or within site logbooks.
- All PE strip handling procedures must be followed in accordance with laboratory specifications and/or site-specific planning documents.
- Standard chain-of-custody procedures should be followed when handling and transporting PE samples from the site to the laboratory.
- All field QC sample requirements in the site-specific QAPP should be followed. This may include trip blanks and field duplicate samples to monitor interferences and cross contamination.

7.0 Health and Safety

When working with potentially contaminated materials (i.e., contaminated sediment), health and safety procedures should be followed as specified in a site-specific HASP. More specifically, when working on or near water bodies, physical hazards must be identified and adequate precautions must be taken to ensure the safety of the sampling team. This should include, at a minimum, wearing adequate protective equipment, flotation devices, and making use of lifelines.

8.0 References

Massachusetts Institute of Technology (MIT). Standard Operating Procedure: Extraction Procedures for PE Media.

Massachusetts Institute of Technology (MIT). Standard Operating Procedure: Preparation of Polyethylene (PE) Media.

U.S. EPA. Environmental Response Team (ERT). Sediment Sampling, SOP No. 2016, Revision 0.0. November 17, 1994.

U.S. EPA Region 1. Soil, Sediment, and Solid Waste Sampling, Revision 2. February 13, 2004.

U.S. EPA Region 9. Sediment Sampling, SOP No. 1215, Revision 1. September 1999.

U.S. EPA. Sampling Equipment Decontamination, SOP No. 2006, Revision 0.0. August 11, 1994.